Agricultural Journal 3 (1): 14-16, 2008
ISSN: 1816-9155


# Effects of Organic Manure Types on Root-Gall Nematode Disease and African Yam Bean Yield

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**Abstract:** Evaluation of the effects of different organic manures on root-gall nematode disease on African yam bean was conducted in a sandy loam soil naturally infested with a root-gall nematode, *Meloidogyne incognita.* The experiment was conducted in a randomized complete block design with four replications. African yam bean plants were treated with sawdust, municipal garbage, swine, compost, poultry and farmyard manures at 2.5 tons $ha^{-1}$. Results showed that severe root-galls occurred on plants treated with sawdust. Plants treated with poultry and farmyard manures were rarely galled. Growth and yield characteristics of the plant were also affected by root-gall damage at the various organic manure treatments.

**Key words:** African yam bean, organic manures, root-galls, growth and yield

## INTRODUCTION

Plant parasitic nematode problems have most commonly been managed by chemical soil treatments and crop rotation (Murphy *et al.*, 1974). Although both practices improve yields of many crops, there are undesirable features associated with each. Crop rotation designed to reduce a specific nematode species often does so at the expense of increasing other species to damaging levels (Brodie *et al.*, 1970; Daulton, 1963; Minton and Donnelly, 1971). Chemical soil treatment, which generally improves crop yields, rarely reduces nematode population densities for more than 2-3 months, resulting in post harvest population densities greater than preplant densities (Brodie and Good, 1973).

Considerable interest has however developed in the possibility of using organic manures to reduce nematode populations and increase crop yields (Johnson, 1962; Mankau and Minteer, 1962; Lear, 1959). This novelty innovation satisfies the undersirable features of chemical soil treatments and crop rotation (Ismaila *et al.*, 1973). Little is however known about the relative efficacy of different organic manures in the control of root nematodes. This study evaluated different organic manures for effective control root-gall nematode disease on African yam bean (Sphenostylist stenocarpa).

## MATERIALS AND METHODS

The study was conducted in the cropping seasons (April-September) of 2005 and 2006 in a sandy loam soil (91.44% sand, 3.44% silt and 5.22% clay) naturally infested with a root-gall nematode, *Meloidogyne incognita.* The nematode's population densities estimated by modified sieving and Bearman's Funnel Technique (Viglierchio and Schmitt, 1983) were 34.12/200cc of soil in 2005 and 36.24/200cc of soil in 2006.

Before planting, the land was cleared, ploughed, harrowed and made into 28 seedbeds (1.2×8 m) at 7 seedbeds $block^{-1}$. The seedbeds were treated by incorporating no manure, sawdust, municipal garbage, farmyard, compost, swine and poultry manures at 0.024 tons $seedbed^{-1}$ (i.e. 2.5 tons $ha^{-1}$) in a randomized complete block design with four replications. The organic manures were earlier analysed for percentage organic carbon, ammonium, potassium, phosphorus and carbon/nitrogen ratios content. All seedbeds were repulverized 7 days later and immediately seeded with African yam bean (Benue brown cv) at 0.8×0.8 m, a population density of 15,625 plants $ha^{-1}$. The plants were staked with two plants/stake and hoe weeding done 40 and 75 days after planting. At 14 day intervals from 30-100 days after plantings, leaf area index (area of leaf materials divided by the ground area over which it is displayed), leaf area growth rate ($cm^2$ $day^{-1}$), number of shoots, seed bearing pods and leaves/stand and plant heights were recorded. Pods and 1000 seeds dry weights were also recorded at harvest (150 days after planting). Root-gall incidence (percentage of infected plants) and severity were measured. Root-gall severity was scored using the following scale: 1 = no root-galls, 2 = 1-25%, 3 = 26- 50%, 4 = 51-75% and 5 = 75-100% roots galled.

Twenty cores (2.5×15 cm) of soil were also collected from the centre rows of each seedbed and processed for nematode population density according to Viglierchio and Schmitt (1983). All data were subjected to analysis of variance (Steel and Torrie, 1981) and means separated by Fisher's least significant difference (Fisher, 1948) at p = 0.05.

## RESULTS AND DISCUSSION

Results of the study showed that incidence and severity of root-gall nematode disease on African yam bean varied with different organic manure treatments (Table 1 and 2). Highest disease incidence and severity occurred on sawdust treated African yam bean plants. These were followed by those on plants treated with municipal garbage. Moderate root-galls occurred where swine or compost manure was applied. Plants treated with poultry manure were rarely galled. The same was true for farmyard manure but with higher disease incidence. Nutrient constituent analysis (Table 3) showed that the different organic manures varied significantly in amounts of potassium, phosphorus, ammonium (in form of nitrogen), organic carbon and carbon/nitrogen ratios. Amounts of these nutrients influenced root-gall nematode damage on the African yam bean. This was as evidenced by severe root-galls associated with sawdust which had high (5%) potassium and very low (0.1%) ammonium contents. Also, poultry manure with high (6.5%) ammonium and low (1%) potassium contents gave rare root-gall damage. These observations agree with that of Otiefa (1959) which stated that root-gall nematode damage on cabbage increased with amounts of potassium available to the host plant because potassium increased the rate of reproduction of the nematode. Huber (1980) also reported that root-gall nematode damage on Lima bean decreased with increased ammonium supplied to the plant.

Growth and yield characteristics of the African yam bean were affected by root-gall nematode damage at the various organic manure treatments (Table 1 and 2). Leaf area index, leaf area growth rate, plant height, number of shoots, leaves and seed bearing pods and weights of dry pods and seeds were significantly reduced at high disease severities resulting from sawdust, municipal garbage and no manure applications. Plants treated with poultry and farmyard manures gave significantly higher yields than those of other organic manures. This was because rare root-galls occurred at poultry and farmyard manure applications. Plants with fewer root-galls would translocate more nutrients to vegetative organs than heavily galled roots (Otiefa and Elgindi, 1962). The C:N ratios of poultry and farmyard manures were also very narrow (Table 3). Miller and Donahue (1990) reported

Table 1: Growth and yield characteristics of African yam bean as affected by root-gall nematode (M. incognita) disease at various organic manure applications in 2005

| Organic manure (2.5 tons $ha^{-1}$) | Disease: Incidence (%) | Disease: Severity (1-5 scale) | Leaf area: Index | Leaf area: Growth rate ($cm^2$ $day^{-1}$) | Number of: Shoots/ stand | Number of: Leaves/ stands | Plant height (cm) | Number of seed bearing pods/ stand | Dry weights of: Pods (gm) | Dry weights of: 1000 seeds (gm) | Nematode counts/ 200 cc of soil at harvest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| No manure | 65.20 | 5.00 | 2.40 | 166.00 | 8.50 | 143.18 | 218.12 | 7.00 | 31.20 | 122.30 | 28.90 |
| Sawdust | 64.90 | 5.00 | 3.20 | 180.04 | 9.00 | 152.40 | 220.24 | 6.68 | 33.10 | 120.00 | 32.44 |
| Swine | 47.80 | 3.40 | 4.96 | 256.06 | 11.70 | 198.02 | 251.15 | 15.06 | 80.40 | 168.15 | 10.43 |
| Poultry | 14.90 | 2.20 | 7.36 | 340.03 | 13.36 | 239.13 | 286.07 | 22.40 | 138.60 | 201.10 | 3.95 |
| Farmyard | 28.60 | 2.40 | 6.80 | 324.05 | 14.56 | 242.22 | 280.04 | 25.80 | 144.00 | 220.40 | 2.75 |
| Municipal garbage | 46.40 | 4.30 | 3.52 | 270.01 | 11.58 | 201.19 | 231.23 | 11.24 | 45.18 | 134.23 | 18.27 |
| Compost | 44.80 | 3.20 | 6.23 | 313.08 | 13.06 | 228.04 | 248.14 | 18.15 | 92.70 | 178.63 | 8.97 |
| $LSD_{0.05}$ | 3.40 | 0.90 | 1.29 | 18.54 | 2.10 | 11.16 | 22.40 | 2.98 | 8.68 | 22.42 | 1.50 |

Table 2: Growth and yield characteristics of African yam bean as affected by root-gall nematode (M. incognita) disease at various organic manure applications in 2006

| Organic manure (2.5 tons $ha^{-1}$) | Disease: Incidence (%) | Disease: Severity (1-5 scale) | Leaf area: Index | Leaf area: Growth rate ($cm^2$ $day^{-1}$) | Number of: Shoots/ stand | Number of: Leaves/ stands | Plant height (cm) | Number of seed bearing pods/ stand | Dry weights of: Pods (gm) | Dry weights of: 1000 seeds (gm) | Nematode counts/ 200 cc of soil at harvest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| No manure | 62.78 | 5.00 | 2.62 | 154.48 | 7.70 | 139.04 | 198.44 | 9.00 | 36.36 | 136.76 | 31.07 |
| Sawdust | 67.03 | 5.00 | 2.90 | 168.17 | 7.23 | 144.30 | 194.05 | 8.64 | 32.14 | 128.26 | 36.56 |
| Swine | 44.54 | 3.01 | 4.14 | 244.38 | 12.18 | 167.15 | 232.43 | 13.42 | 68.82 | 155.24 | 12.04 |
| Poultry | 20.15 | 2.12 | 7.76 | 322.12 | 12.04 | 231.18 | 256.48 | 23.01 | 55.22 | 218.00 | 2.84 |
| Farmyard | 22.63 | 2.43 | 7.22 | 312.44 | 13.24 | 236.14 | 261.22 | 24.61 | 161.78 | 226.18 | 3.01 |
| Municipal garbage | 45.19 | 4.16 | 4.14 | 258.62 | 10.28 | 198.42 | 220.13 | 10.04 | 54.06 | 121.67 | 21.54 |
| Compost | 44.16 | 3.12 | 6.06 | 301.12 | 12.44 | 222.06 | 240.33 | 15.10 | 84.21 | 164.18 | 10.18 |
| $LSD_{0.05}$ | 4.86 | 0.52 | 1.12 | 20.01 | 1.72 | 8.15 | 12.02 | 3.18 | 12.23 | 18.86 | 2.07 |

Table 3: Approximate percentage of organic carbon, ammonium (nitrogen form), potassium, phosphorus, carbon/nitrogen ratio of organic manures (dry-weight basis)

| Constituent | Sawdust (%) | Poultry (%) | Farmyard (%) | Municipal garbage (%) | Compost(%) | Swine (%) |
|---|---|---|---|---|---|---|
| Organic carbon (c) | 60.0 | 20.0 | 50.0 | 40.0 | 40.0 | 450 |
| Ammonium (N) | 0.1 | 6.5 | 4.0 | 0.5 | 1.3 | 1.5 |
| C: N ratio (C/N) | 600:1 | 4:1 | 12:1 | 80:1 | 30:1 | 30:1 |
| Potassium (K) | 5.0 | 1.0 | 2.0 | 4.0 | 3.0 | 2.0 |
| Phosphorus (P) | 2.0 | 1.0 | 1.5 | 2.0 | 3.5 | 1.0 |

that organic residues with C:N ratios of 20:1 or narrower have sufficient nitrogen to supply to the decomposing microorganisms and also to release for plant use.

## CONCLUSION

Application of sawdust as a soil amendment aggravated root-gall nematode damage on African yam bean in a sandy loam soil. This was as opposed to significant reductions in root-gall nematode damage caused by municipal garbage, swine, compost, poultry and farmyard manure applications. Poultry and farmyard manures most effectively controlled the disease and improved African yam bean growth and yield.

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